

## **Description**

The first paragraph of Section 5-04.1 is supplemented with the following:

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This work shall consist of providing and placing Quieter Pavement overlays consisting of Open Graded Friction Course (OGFC) and Open Graded Friction Course Asphalt-Rubber (OGFC-AR) on the existing roadway in accordance with these Specifications and lines, grades, thicknesses, and typical cross-sections shown in the Plans and shall meet the requirements for hot-mix asphalt as modified herein.

OGFC shall consist of a mixture of asphalt, mineral aggregate, mineral filler, and other additives properly proportioned, mixed and applied on a paved surface.

OGFC-AR shall consist of a mixture of rubberized asphalt, mineral aggregate, mineral filler and other additives properly proportioned, mixed and applied on a paved surface.

## **Materials**

The first paragraph of Section 5-04.2 is supplemented with the following:

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Portland Cement, Type II 9-02.1(1)

Hydrated Lime                      ASTM C 1097

The third paragraph of Section 5-04.2 is supplemented with the following:

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The use of RAP shall not be used in the OGFC or OGFC-AR.

The fourth paragraph of Section 5-04.2 is supplemented with the following:

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Asphalt binder material for the OGFC shall be PG 70-22. SBS modifier shall be added to the neat asphalt to produce a binder that complies with the requirements for PG 70-22.

Asphalt binder material for the OGFC-AR shall be asphalt-rubber conforming to the requirements of Asphalt Rubber (A). The crumb rubber gradation shall conform to the requirements of Asphalt-Rubber (B).

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated shall be rejected.

## ***Asphalt-Rubber***

### **(A) Asphalt Binder**

Asphalt binder shall be PG 58-22 or PG 64-22 conforming to the requirements of 9-02, Bituminous Materials.

### **(B) Crumb Rubber**

Rubber shall meet the following gradation requirements when tested in accordance with AASHTO T 11/27.

<b>Sieve Size</b>	<b>Percent Passing</b>
No. 8	100
No. 10	100
No. 16	65 – 100
No. 30	20 – 100
No. 50	0 – 45
No. 200	0 – 5

The rubber shall have a specific gravity of  $1.15 \pm 0.05$  and shall be free of wire or other contaminating materials, except that the rubber shall contain not more than 0.5 percent fabric. Calcium carbonate, up to four percent by weight of the granulated rubber, may be added to prevent the particles from sticking together.

Certificates of Compliance conforming to 1-06.3 shall be submitted. In addition, the certificates shall confirm that the rubber is a crumb rubber, derived from processing whole scrap tires or shredded tire materials; and the tires from which the crumb rubber is produced are taken from automobiles, trucks, or other equipment owned and operated in the United States. The certificates shall also verify that the processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above ground.

### ***Asphalt-Rubber Proportions***

The asphalt-rubber shall contain a minimum of 20 percent ground rubber by the weight of the asphalt binder.

### ***Asphalt-Rubber Properties***

Certificate of Compliance conforming to 1-06.3 shall be submitted to the Engineer showing that the asphalt-rubber conforms to the following:

<b>Property</b>	<b>Requirement</b>
Rotational Viscosity*: 350 °F; pascal seconds	1.5 - 4.0
Penetration: 39.2 °F, 200 g, 60 sec. (ASTM D 5); minimum	15
Softening Point: (ASTM D 36); °F, minimum	130
Resilience: 77 °F (ASTM D 5329); %, minimum	25

\* The viscotester used must be correlated to a Rion (formerly Haake) Model VT-04 viscotester using the No. 1 Rotor. The Rion viscotester rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350 to 355 F for a minimum heat equilibrium period of 60 seconds, and the average viscosity determined from three separate constant

readings ( $\pm 0.5$  pascal seconds) taken within a 30 second time frame with the viscotester level during testing and turned off between readings. Continuous rotation of the rotor may cause thinning of the material immediately in contact with the rotor, resulting in erroneous results.

### ***Asphalt-Rubber Binder Design***

At least two weeks prior to the use of asphalt-rubber, the Contractor shall submit an asphalt-rubber binder design prepared by one of the following laboratories who have experience in asphalt-rubber binder design:

MACTEC Engineering and Consulting, Inc.

Contact: Anne Stonex

Address: 3630 East Wier Avenue  
Phoenix, Arizona 85040

Phone: (602) 437-0250

Western Technologies, Inc.

Contact: John Hahle

Address: 2400 East Huntington Drive  
Flagstaff, Arizona 86004

Phone: (928) 774-8700

Such design shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt binder used; and percent, gradation and source(s) of rubber used.

### **Construction Requirements**

Section 5-04.3 shall be supplemented with the following:

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During production of asphalt-rubber, the Contractor shall combine materials in conformance with the asphalt-rubber design unless otherwise approved by the Engineer.

Direct transfer of the OGFC and OGFC-AR from the hauling equipment to the paving machine will not be allowed. A Shuttle Buggy will be required to deliver the OGFC and OGFC-AR from the hauling equipment to the paving machine.

### ***Mixing of Asphalt-Rubber***

The temperature of the asphalt binder shall be between 350 and 400°F at the time of addition of the ground rubber. No agglomerations of rubber particles in excess of two inches in the least dimension shall be allowed in the mixing chamber. The ground rubber and asphalt binder shall be accurately proportioned in accordance with the design and thoroughly mixed prior to the beginning of the one-hour reaction period. The Contractor shall document that the proportions are accurate and that the rubber has been uniformly incorporated into the mixture. Additionally, the Contractor shall demonstrate that the rubber particles have been thoroughly mixed such that they have been "wetted." The occurrence of rubber floating on the surface or agglomerations of rubber particles shall be evidence of insufficient mixing. The temperature of the asphalt-rubber immediately after mixing shall be between 325 and 375°F. The asphalt-rubber shall be maintained at such temperature for one hour before being used.

Prior to use, the viscosity of the asphalt-rubber shall be tested and conform to the asphalt-rubber properties, which is to be furnished by the Contractor or supplier.

### ***Handling of Asphalt-Rubber***

Once the asphalt-rubber has been mixed, it shall be kept thoroughly agitated during periods of use to prevent settling of the rubber particles. During the production of asphaltic concrete the temperature of the asphalt-rubber shall be maintained between 325 and 375°F. However, in no case shall the asphalt-rubber be held at a temperature of 325°F or above for more than 10 hours. Asphalt-rubber held for more than 10 hours shall be allowed to cool and gradually reheated to a temperature between 325 and 375°F before use. The cooling and reheating shall not be allowed more than one time. Asphalt-rubber shall not be held at temperatures above 250°F for more than four days.

For each load or batch of asphalt-rubber, the contractor shall provide the Engineer with the following documentation:

1. The source, grade, amount and temperature of the asphalt binder prior to the addition of rubber.
2. The source and amount of rubber and the rubber content expressed as percent by the weight of the asphalt binder.
3. Times and dates of the rubber additions and resultant viscosity test.
4. A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 20°F, and as needed to document other events which are significant to batch use and quality.

### ***HMA Mixing Plant***

Section 5-04.3(1) shall be is supplemented with the following:

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#### **Fiber Supply System**

When fiber stabilizing additives are required for OGFC, a separate feed system that meets the following will be required:

- 1) Accurately proportions by weight the required quantity into the mixture in such a manner that uniform distribution will be obtained.
- 2) Provides interlock with the aggregate feed or weigh systems so as to maintain the correct proportions for all rates of production and batch sizes.
  - a) Controls dosage rate accurately to within plus or minus 10 percent of the amount of fibers required.
  - b) Automatically adjusts the feed rate to maintain the material within the 10 percent tolerance at all times.
  - c) Provides flow indicators or sensing devices for the fiber system that are interlocked with plant controls so that mixture production will be interrupted if introduction of the fiber fails or if the output rate is not within the tolerances given above.
- 3) Provides in-process monitoring, consisting of either a digital display of output or a printout of feed rate, in pounds per minute to verify the feed rate.

When a batch type plant is used, the fiber shall be added to the aggregate in the weigh hopper or as approved by the Engineer. The batch dry mixing time shall be increased by 8

to 12 seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the mixer. The fibers are to be uniformly distributed prior to the injection of the asphalt binder into the mixer.

When a continuous or drier-drum type plant is used, the fiber shall be added to the aggregate and uniformly dispersed prior to the injection of asphalt binder. The fiber shall be added in such a manner that it will not become entrained in the exhaust system of the dryer or plant.

### **Surge and Storage Systems**

The storage time for OGFC mixtures not hauled immediately to the project shall be no more than 4 hours.

### **Hot Mix Asphalt Pavers**

Section 5-04.3(3) is supplemented with the following:

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For OGFC and OGFC-AR the direct transfer of these materials from the hauling equipment to the paving machine will not be allowed. A Shuttle Buggy shall be used to deliver the OGFC and OGFC-AR from the hauling equipment to the paving machine.

The Shuttle Buggy shall mix the OGFC and OGFC-AR after delivery by the hauling equipment but prior to laydown by the paving machine. Mixing of the OGFC and OGFC-AR shall be sufficient to obtain a uniform temperature throughout the mixture.

### **Rollers**

Section 5-04.3(4) is supplemented with the following:

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The wheels of the rollers used for Quieter Pavement shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the OGFC or OGFC-AR from sticking to the steel wheels during rolling.

A minimum of three static steel wheel rollers, weighing no less than eight tons, shall be provided. The drums shall be of sufficient width that when staggered, two rollers can cover the entire lane width.

Vibratory rollers must be used in the static mode only.

A pass shall be defined as one movement of a roller in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

Two rollers shall be used for initial breakdown and be maintained no more than 300 feet behind the paving machine. The roller(s) for final compaction shall follow as closely behind the initial breakdown as possible. As many passes as is possible shall be made with the rollers before the temperature of the OGFC or OGFC-AR falls below 220 °F.

### **Preparation Of Existing Surfaces**

Section 5-04.3(5)A is supplemented with the following:

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For OGFC and OGFC-AR, a tack coat of CRS-2 or CRS-2P shall be applied to the existing surface at a rate of 0.12 to 0.20 (0.08 to 0.12 residual) gallons per square yard or as otherwise directed by the Engineer.

(NWR February 9, 2004)

The Contractor shall limit the amount of tack coat placed to that amount that will be fully covered by the asphalt overlay at the end of each work shift.

In accordance with Section 1-07.15(1) **Spill Prevention, Control and Countermeasures Plan** (SPCC), as part of the SPCC the Contractor shall address the mitigating measures to be taken in the event that the paving operation is suspended or terminated prior to the asphalt for tack coat being fully covered.

### **Mix Design**

Section 5-04.3(7)A is supplemented with the following:

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4. **Mix Design (OGFC-AR)** Approximately 500 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained that are representative of the mineral aggregate to be utilized in the OGFC-AR production.

The Contractor shall also furnish representative samples of the following materials: a five-pound sample of the crumb rubber proposed for use, one gallon of asphalt binder from the intended supplier, five gallons of the proposed mixture of binder and rubber, and a one-gallon can of the mineral admixture to be used in the OGFC-AR.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail its methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and any special or limiting conditions it may propose. The Contractor's letter shall also state the source(s) of mineral aggregate, the source of asphalt binder and crumb rubber, the asphalt-rubber supplier, and the source and type of mineral admixture.

The above materials and letter shall be shipped to the Arizona DOT Central Laboratory at 1221 North 21st Avenue, Phoenix, AZ 85009 (Attention – Julie Nodes), with companion materials and letter sent to the WSDOT State Materials Laboratory in Tumwater. Within 10 working days of receipt of all samples and the Contractor's letter in the Arizona DOT Central Laboratory, the Arizona DOT will provide the Contractor with the percentage of asphalt-rubber to be used in the mix, the percentage to be used from each of the stockpiles of mineral aggregate, the composite mineral aggregate gradation, the composite mineral aggregate and mineral admixture gradation, and any special or limiting conditions for the use of the mix.

**Mix Design (OGFC)** Mixtures shall be compacted with 50 gyrations of a Superpave Gyratory Compactor and the draindown at the mix production temperature (AASHTO T 305) shall be 0.3 max.

5. **Mix Design Revisions.** The Contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer, or without requesting a new mix design.

During production of OGFC and OGFC-AR, the Contractor, on the basis of field test results, may request a change to the approved mix design. The Engineer will evaluate the proposed changes and notify the contractor of the Engineer's decision within two working days of the receipt of the request.

If, at any time, unapproved changes are made in the source of bituminous material, source(s) of mineral aggregate, production methods, or proportional changes in violation of approved mix design stipulations, production shall cease until a new mix design is developed, or the Contractor complies with the approved mix design.

At any time after the mix design has been approved, the Contractor may request a new mix design.

The costs associated with the testing of materials in the developing of mix designs after a mix design acceptable to the Department has been developed shall be borne by the Contractor.

If, during production, the Engineer on the basis of testing determines that a change in the mix design is necessary, the Engineer will issue a revised mix design. Should these changes require revisions to the Contractor's operations which result in additional cost to the Contractor, it will be reimbursed for these costs.

6. **Fiber Stabilizing Additives.** If needed, fiber stabilizing additives shall consist of either cellulose fibers, cellulose pellets or mineral fibers and meet the properties described below. Dosage rates given are typical ranges but the actual dosage rate used shall be approved by the Engineer.

A. Cellulose Fibers: Cellulose fibers shall be added at a dosage rate between 0.2% and 0.5% by weight of the total mix as approved by the Engineer. Fiber properties shall be as follows:

1.	Fiber length:	0.25 inch (6 mm) max.
2.	Sieve Analysis	
	a. Alpine Sieve Method Passing No. 100 sieve:	60-80%
	b. Ro-Tap Sieve Method Passing No. 20 sieve: Passing No. 40 sieve: Passing No. 100 sieve:	80-95% 45-85% 5-40%
3.	Ash Content:	18% non-volatiles (±5%)
4.	pH:	7.5 (±1.0)
5.	Oil Absorption: (times fiber weight)	5.0 (±1.0)
6.	Moisture Content:	5.0% max.

- B. Cellulose Pellets: Cellulose pellets shall consist of cellulose fiber and may be blended with up to 20% asphalt cement. If no asphalt cement is used, the fiber pellet shall be added at a dosage rate between 0.2% and 0.5% by weight of the total mix. If asphalt cement is blended with the fiber, the pellets shall be added at a dosage rate between 0.4% and 0.8% by weight of the total mix.

1.	Pellet size:	1/4 in <sup>3</sup> (6 mm <sup>3</sup> ) max.
2.	Asphalt:	25 - 80 pen.

- C. Mineral Fibers: Mineral fibers shall be made from virgin basalt, diabase, or slag and shall be treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber surface to the bitumen. The fiber shall be added at a dosage rate between 0.2% and 0.5% by weight of the total mix.

1.	Size Analysis:	
	Average Fiber length:	0.25 in. (6 mm) max.
	Average Fiber thickness:	0.0002 in. (0.005mm) max.
2.	Shot content (ASTM C1335)	
	Passing No. 60 sieve (250 µm):	90 - 100%
	Passing No. 230 sieve (63 µm):	65 - 100%

### **Acceptance Sampling and Testing – HMA Mixture**

Section 5-04.3(8)A is revised as follows:

Item 3 is supplemented with the following:

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#### **Sampling - OGFC and OGFC-AR**

OGFC and OGFC-AR will be evaluated for quality of gradation based on samples taken from the cold feed bin.

Item 5 is supplemented with the following:

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#### **Test Results - OGFC and OGFC-AR**

##### **Mineral Aggregate Gradation - OGFC**

For the OGFC, a sample shall be taken in accordance with WSDOT T-2 on a random basis just prior to the addition of mineral admixture and bituminous materials. At least one sample shall be taken during the production of the OGFC. Samples will be tested for conformance with the mix design gradation. The gradation of the mineral aggregate shall be considered to be acceptable, unless average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Mixture Control Tolerance
3/8 Inch	± 5.7
No. 4	± 5.5
No. 8	± 4.5
No. 200	± 2.0

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##### **Mineral Aggregate Gradation - OGFC-AR**

For each approximate 300 tons of OGFC-AR, at least one sample of mineral aggregate shall be taken. Samples shall be taken in accordance with WSDOT T-2 on



a random basis just prior to the addition of mineral admixture and bituminous materials. Samples will be tested for conformance with the mix design gradation. The gradation of the mineral aggregate shall be considered acceptable, unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	3 Consecutive	One
No. 4	$\pm 4$	$\pm 4$
No. 8	$\pm 3$	$\pm 4$
No. 200	$\pm 1.0$	$\pm 1.5$

(January 3, 2006)

The first paragraph of item 5 is revised to read:

The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed in the field within either 24 hours of sampling or four hours after the beginning of the next paving shift, whichever is later. The Engineer will also provide the Composite Pay Factor (CPF) of the completed sublots after three sublots have been produced. The CPF will be provided by the midpoint of the next paving shift after sampling results are completed.

The first sentence in the second paragraph of item 5 is revised to read:

Sublot sample test results (gradation, asphalt binder content, VMA and Va) may be challenged by the Contractor.

The third paragraph of item 5 is revised to read:

The results of the challenge sample will be compared to the original results of the acceptance sample test and evaluated according to the following criteria:

	<b>Deviation</b>
U.S. No. 4 sieve and larger	Percent passing $\pm 4.0$
U.S. No. 8 sieve	Percent passing $\pm 2.0$
U.S. No. 200 sieve	Percent passing $\pm 0.4$
Asphalt binder %	Percent binder content $\pm 0.3$
VMA %	Percent VMA $\pm 1.5$
Va %	Percent Va $\pm 0.7$

The last sentence of item 75 is revised to read:

The calculation of the CPF in a test section with a mix design that did not verify will include gradation, asphalt binder content, VMA and Va.

Item 7 is supplemented with the following:

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**Test Section - OGFC**

A mixture test section shall be constructed off-site prior to production paving of the OGFC. The test section shall be used to determine if the mix meets the requirements of mineral aggregate gradation and recommended asphalt binder content.

For the test section to be acceptable the mineral aggregate gradation shall be within the limits as shown in 5-04.3(8)A as supplemented and the asphalt content varies by no more than  $\pm 0.5$  percent.

**Test Section - OGFC-AR**

A mixture test section shall be constructed off-site prior to production paving of the OGFC-AR. The test section shall be used to determine if the mix meets the requirements of mineral aggregate gradation and recommended asphalt-rubber binder content.

For the test section to be acceptable the mineral aggregate gradation shall be within the limits as shown in 5-04.3(8)A as supplemented and the asphalt-rubber content varies by no more than  $\pm 0.5$  percent.

**Compaction**

(NWR March 1, 2004)

**Control**

The first sentence of item 1 in Section 5-04.3(10)B is revised to read:

HMA used in traffic lanes, including lanes for ramps, truck climbing, weaving, speed change, and shoulders, and having a specified compacted course thickness greater than 0.10 foot, shall be compacted to a specified level of relative density.

**Joints**

Section 5-04.3(12) is supplemented with the following:

(NWR May 9, 2005)

**Transverse Joint Seal**

The Contractor shall construct contraction joints at the bridge ends/bents as shown in the Plans. The joints shall be sawed to the dimensions shown in the Plans and filled with joint sealant filler meeting the requirement of Section 9-04.2(1).

Joints shall be thoroughly clean and dry at the time of sealing. Care shall be taken to avoid air pockets. The compound shall be applied in two or more layers, if necessary.

**Planing Bituminous Pavement**

Section 5-04.3(14) is supplemented with the following:

(January 5, 2004)

The Contractor shall perform the planing operations no more than \*\*\* five \*\*\* calendar days ahead of the time the planed area is to be paved with HMA, unless otherwise allowed by the Engineer in writing.

(January 5, 2004)

At the start of the planing operation the Contractor shall plane a 500 foot test section to be evaluated by the Engineer for compliance with the surface tolerance requirements. The

test section shall have a minimum width of 10 feet. If the planing is in accordance with the surface tolerance requirements, the Contractor may begin production planing. If the planing is not in conformance with the surface tolerance requirements, the Contractor shall make adjustments to the planing operation and then plane another test section.

If at any time during the planing operation the Engineer determines the required surface tolerance is not being achieved, the Contractor shall stop planing. Planing shall not resume until the Engineer is satisfied that specification planing can be produced or until successful completion of another test section. The forward speed during production planing shall not exceed the speed used for the test section.

The completed surface after planing and prior to paving shall not vary more than 1/4 inch from the lower edge of a 10-foot straightedge placed on the surface parallel or transverse to the centerline. The planed surface shall have a matted texture and the difference between the high and low of the matted surface shall not exceed 1/8 inch.

Pavement repair operations, when required, shall be accomplished prior to planing.

**(January 3, 2006)**

**Transverse Joints**

The full depth end of each lane of planing shall be squared off to form a uniform transverse joint. The Contractor shall construct and maintain a temporary HMA wedge in accordance with Section 5-04.3(11) across the entire width of the transverse edge when traffic is allowed on the planed surface prior to paving. The wedge shall be constructed before opening the lane to traffic. The Contractor shall remove the wedge immediately prior to paving.

**(NWR May 9, 2005)**

**Transverse Joint Seal**

The Contractor shall construct contraction joints at the bridge ends/bents as shown in the Plans. The joints shall be sawed to the dimensions shown in the Plans and filled with joint sealant filler meeting the requirement of Section 9-04.2(1).

Joints shall be thoroughly clean and dry at the time of sealing. Care shall be taken to avoid air pockets. The compound shall be applied in two or more layers, if necessary.

***Weather Limitations***

Section 5-04.3(16) is supplemented with the following:

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The mixing and placing of OGFC and OGFC-AR shall not be performed when the existing pavement is wet or frozen. OGFC and OGFC-AR shall not be placed when the air temperature is less than 55°F.

**Measurement**

Section 5-04.4 is supplemented with the following:

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Open-Graded Friction Course and Open-Graded Friction Course Asphalt Rubber will be measured by the ton in accordance with Section 1-09.2, with no deduction being made for the weight of asphalt binder, blending sand, mineral filler or any other component of the mixture.

(NWR May 9, 2005)

Transverse joint seal will be measured by the linear foot of joint sealed.

### **Payment**

Section 5-04.5 is supplemented with the following:

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"Open Graded Friction Course", per ton.

"Open Graded Friction Course" - Asphalt Rubber", per ton.

The unit contract price per ton for "Open-Graded Friction Course" and "Open-Graded Friction Course Asphalt Rubber" shall be full compensation for all costs incurred to carry out the requirements of Section 5-04 except for those costs included in other items which are included in this sub-section and which are included in the proposal.

(NWR May 9, 2005)

"Transverse Joint Seal", per linear foot.

The unit contract price for "Transverse Joint Seal" shall be full pay to complete the work as specified.

### **Price Adjustment for Quality of HMA**

The first paragraph of Section 5-04.5(1)A is revised to read:

Statistical analysis of quality of gradation, asphalt content and volumetric properties will be performed based on Section 1-06.2 using the following price adjustment factors:

<b>Table of Price Adjustment Factors</b>	
<b>Constituent</b>	<b>Factor "f"</b>
VMA (Voids in mineral aggregate)	30
Va (Air Voids)	30
All aggregate passing 1/2"	2
All aggregate passing 3/8"	2
All aggregate passing U.S. No. 4	2
All aggregate passing U.S. No. 8	15
All aggregate passing U.S. No. 200	15
Asphalt Binder Content	30

The first two sentences of the second paragraph are revised to read:

A pay factor will be calculated for sieves listed as a control point for the class of HMA, for the asphalt binder and volumetric properties (VMA and Va).